(19) European Patent Office
Office européen des brevets

(11) Publication number: 0 111 568 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(21) Application number: 83901629.2

(22) Date of filing: 26.05.83

(51) Int. Cl.³: H 01 B 3/12
H 01 G 4/08, H 05 B 3/22

Data of the international application taken as a basis:

(86) International application number:
PCT/JP83/00164

(87) International publication number:
WO83/04339 (08.12.83 83/28)

(30) Priority: 28.05.82 JP 91594/82
03.06.82 JP 95430/82

(43) Date of publication of application:
27.06.84 Bulletin 84/26

(84) Designated Contracting States:
DE FR GB

(71) Applicant: Matsushita Electric Industrial Co., Ltd.
1006, Oaza Kadoma
Kadoma-shi Osaka-fu, 571(JP)

(72) Inventor: FUJITA, Yosuke
8-20-407, Isecho Ashiya-shi
Hyogo-ken 659(JP)

(72) Inventor: TOHDA, Takao
11-38, Nishiasahigaoka Ikoma-shi
Nara-ken 630-02(JP)

(72) Inventor: MATSUOKA, Tomizo
31-30, Ishizuhigashimachi Neyagawa-shi
Osaka-fu 572(JP)

(72) Inventor: ABE, Atsushi
8-1, Asukanominami 3-chome
Ikoma-shi Nara-ken 630-01(JP)

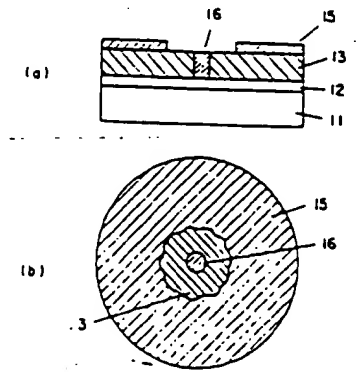
(72) Inventor: NITTA, Tsuneharu
15-18, Myokenzaka 2-chome Katano-shi
Osaka-fu 576(JP)

(74) Representative: Patentanwälte Leinweber & Zimmermann
Rosental 7/II Aufg.
D-8000 München 2(DE)

(54) THIN FILM ELECTRIC FIELD LIGHT-EMITTING DEVICE.

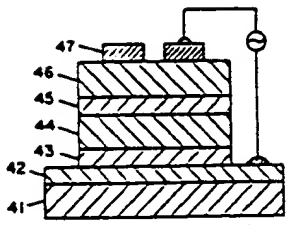
(57) A thin film electric field light-emitting device has a thin fluorescent film, a thin dielectric film, and electrodes for applying a voltage to the films, the thin dielectric film is composed of a dielectric expressed by the general formula AB_2O_6, where A is a 2-valency metallic element and B a 5-valency metallic element. This dielectric is used to reduce the drive voltage without decreasing the intensity of the light emitted by the light-emitting device. Further, a composite laminate of thin dielectric films in which thin dielectric films that do not break down a self-recovery type of insulator are used, thereby causing the entire composite thin dielectric film to break down the self-recovery type of insulator in such a manner that the value of the product of the insulating breakdown electric field intensity and the specific dielectric constant is large, thereby providing a thin film electric field light-emitting device with excellent characteristics.

FIG. 1



P 0 111 568 A1

FIG. 4



0111568

SPECIFICATION

TITLE MODIFIED
see front page

THIN FILM ELECTROLUMINESCENT ELEMENT

TECHNICAL FIELD

This invention relates to a thin film luminescent element producing luminescence under application of electric field.

BACKGROUND ART

In a thin film EL (electroluminescent) element producing luminescence in response to application of an electric field, increased brightness is attempted to be attained with such a structure in which a phosphor thin film having one or both surfaces deposited with a dielectric thin film is sandwiched between two electrode layers. The element of the structure in which the dielectric thin film is provided on one surface of the phosphor thin film is characterized by a simplified structure and a low driving voltage. The element of the structure in which both surfaces of the phosphor thin film layer are provided with dielectric thin films, respectively, is advantageous in that dielectric breakdown is difficult to occur and that brightness is significantly increased. As the phosphor material used to this purpose, there are known ZnS, ZnSe, ZnF_2 or the like added with an activator. In particular, in the

case of an element employing phosphor which is composed of ZnS as a host material and added with Mn as the activator for light emission, brightness in the range of 3500 to 5000 cd/m^2 at maximum is attained. As the typical dielectric material, there may be mentioned Y_2O_3, SiO, Si_3N_4, Al_2O_3, Ta_2O_5 and the like. The layer of ZnS is of thickness in a range of 500 to 700 nm, has a dielectric constant of about 9. The thickness of the dielectric film is in a range of 400 to 800 nm and has a dielectric constant in a range of 4 to 25.

When the element is driven by using an AC voltage, the voltage applied across the element is divided between the layer of ZnS and the dielectric thin film, wherein a voltage on the order of about 40% to 60% of the voltage applied across the electrodes makes appearance across the layer of ZnS. The voltage required for producing brightness thus becomes higher in appearance. In the case of the element having both surfaces provided with the dielectric thin films, respectively, brightness is produced by applying a voltage higher than 200 V, inclusive thereof, in the pulse-voltage driving at a frequency in the order of KHz in the present state of art. Such a high voltage imposes a great load on the driving circuit, involving the necessity for using a special integrated circuit (IC) capable of withstanding a high voltage and giving rise to the problem of inexpensiveness.

In this connection, it is proposed to use as the dielectric thin film such a thin film which contains $TbTiO_3$, $Pb(Ti_{1-x}Zr_x)O_3$ or the like as a main component and exhibits a high dielectric constant, with a view to lowering the driving voltage. Although this type thin film has as high a dielectric constant (hereinafter represented by ε_γ) as 100 or more, electric field intensity at which the dielectric breakdown occurs (hereinafter represented by E_b) is as low as 0.5 MV/cm, which means that the film thickness be significantly increased when compared with that of the heretofore used dielectric material. In the case of the element designed for high brightness, it is required that the thickness of the ZnS-layer be on the order of 0.6 μm. Further, from the stand point of reliability of the element, the aforementioned dielectric thin film has to be realized in thickness not smaller than 1.5 μm. When temperature of the substrate is high, increase in the film thickness results in that growth of particles within the film takes place. As the consequence, the film becomes turbid in white, decreasing the transmittivity of light. In the EL element in which such white-turbid film is employed and which is implemented in an X-Y matrix configuration, even a non-selected pixel will become effective to scatter light emitted by other pixels, involving the troublesome problem of cross-talk.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view for illustrating a self-healing type dielectric breakdown in a dielectric layer, and Fig. 2 is a view for illustrating a dielectric breakdown in a dielectric layer which is not of the self-healing nature. Fig. 3 is a sectional view of a thin film electroluminescent element shown for the purpose of comparison with the element according to the invention, and Fig. 4 is a sectional view showing a thin film electroluminescent element according to an exemplary embodiment of the present invention. Figs. 5 and 6 are sectional views showing, respectively, other exemplary embodiments of the thin film electroluminescent element according to this invention.

BEST MODE FOR CARRYING OUT THE INVENTION

With the present invention, it is intended to solve the problems described hereinbefore. It is proposed according to the invention to use a dielectric layer which has a composition generally expressed by AB_2O_6 where A represents a divalent metal element, B represents a pentavalent metal element (and O represents oxygen) and which exhibits ε_γ and E_b of large values, to thereby allow the driving voltage to be lowered without decreasing brightness of the hitherto known thin film EL element.

In an AC-driven thin film EL element, the

voltage applied across the dielectric layer is represented by a product $t_i \cdot E_i$, where t_i represents the film thickness of the dielectric thin film and E_i represents the electric field intensity applied to the dielectric thin film. The voltage applied across the phosphor thin film becomes more effective as the value of $t_i \cdot Ei$ is smaller. It is safe to say that t_i be in inverse proportion to E_b of the dielectric thin film in order that the element can operate stably without undergoing the dielectric breakdown. Among E_i, the electric field intensity E_Z in the phosphor thin film, the dielectric constant ε_Z of the phosphor thin film and ε_γ of the dielectric thin film, a relationship of $E_i = E_Z \cdot \varepsilon_Z / \varepsilon_\gamma$ applies valid. E_i is in inverse proportion to ε_γ, providing E_Z and ε_Z to be constant. Accordingly, it can be said that $t_i \cdot E_i$ is approximately in inverse proportion to the product of E_b and ε_r. The dielectric thin film is more advantageous with $E_b \cdot \varepsilon_\gamma$ of not high value.

The dielectric thin film expressed by the general formula of AB_2O_6 and used according to the teaching of the present invention exhibits $E_b \cdot \varepsilon_\gamma$ of a greater value than that of the heretofore used material and is preferable as the dielectric thin film for the EL element. In connection with the above formula, A represents a divalent metal element such as Pb, Sn, Zn, Cd, Ba, Sr, Ca and Mg, and B represents Ta or Nb. A bulk or mass of a compound of these elements exhibit ε_γ of a

great value. By way of example, it is reported that ε_γ of $PbNb_2O_6$ is 300, that of $PbTa_2O_6$ is 300 and that ε_γ of $(Pb_{0.55}\ Sr_{0.45})\ Nb_2O_6$ is 1600. In the case of a thin film, it is difficult to realize ε_γ of the same value as the bulk. However, ε_γ of a value not smaller than 40 can be easily realized in a thin film fabricated by a sputtering process. In addition, E_b of the thin film is as high as 2×10^6 V/cm or more. The value of $E_b \cdot \varepsilon_\gamma$ of such thin film is not smaller than 80×10^6 V/cm. It will be seen that the thin film formed of the compound mentioned above is excellent over the material used heretofore such as, for example, Y_2O_3, Al_2O_3 and Si_3N_4 whose values of $E_b \cdot \varepsilon_\gamma$ are about 50×10^6 V/cm, 30×10^6 V/cm and 70×10^6 V/cm, respectively. In the compound expressed by the general formula of AB_2O_6, Nb and Ta which are most stable in pentavalence are preferable as the element represented by B. Among the divalent elemnts represented by A, Sr, Ba and Pb are very preferable. Above all, $PbTa_2O_6$ and $PbNb_2O_6$ where the element represented by A is Pb and whose values of $E_b \cdot \varepsilon_\gamma$ are 150×10^6 V/cm and 120×10^6 V/cm, respectively, provide very excellent thin film materials for the EL element. The thin film is formed by an RF sputtering method with a ceramic being used as a target. As the temperature of the substrate on which the thin film is to be formed is higher, the value of ε_γ of the thin film as formed becomes correspondingly greater. The

dielectric breakdown field intensity E_b assumes a substantially constant value when the temperature of the substate is lower than about 400°C and is gradually decreased when the substrate temperature is elevated to a higher temperature. The value of $E_b \cdot \varepsilon_\gamma$ becomes greatest when the temperature of the substrate is approximately at 400°C. In the range of temperature mentioned above, no adverse influence will be exerted to the phosphor thin film. Besides, glass may be used as the material for the substrate without giving rise to a problem such as thermal deformation of the substrate. Moreover, no turbidity in white will be produced due to the growth of particles.

Unless the temperature of the substrate is sufficiently high, the thin film will be found to be amorphous when investigated by means of X-ray diffraction. Through chemical analysis and phosphor X-ray analysis, it has been ascertained that the thin film has a composition substantially coinciding with the general formula of AB_2O_6.

In general, various defects are produced in the thin film by pinholes, dusts and the like. When a voltage is applied to the dielectric thin film, dielectric breakdown is likely to take place at the defective locations at a lower voltage rather than the indefective locations.

The dielectric breakdown may generally be

classified into two types. One is the dielectric breakdown of self-healing type. More specifically, referring to Fig. 1, an upper electrode 15 overlying a location 16 where the dielectric breakdown has occurred is eliminated away over an area of several ten μm under discharging energy, wherein the upper electrode 15 is disconnected from a lower electrode 12. The dielectric breakdown occurring in the dielectric thin film of the composition expressed by the general formula AB_2O_6 where A represents a divalent metal element and B represents a pentavalent metal element is of this type. A numeral 11 denotes a substrate, and 13 denotes a dielectric thin film. The other is the dielectric breakdown of the self-healing type. As is shown in Fig. 2, the upper electrode 25 is eliminated away only to such a small degree that the upper electrode 25 is electrically short-circuited to the lower electrode 22 through a hole 26 formed by the dielectric breakdown. When the voltage continues to be applied in this state, the dielectric breakdown may spread over the whole dielectric film. The dielectric thin film containing perovskite type titanate as a main component belongs to this type.

As the thickness of the upper electrode is decreased, the dielectric breakdown is more unlikely to occur. However, if the thickness is decreased excessively, resistance of the electrode is increased, to a disadvantage. Accordingly, the electrode should

have a thickness of several tens nm at minimum. Electrode material such as Au, Zn, Al and others is most likely to undergo the dielectric breakdown of the self-healing type. However, there exist some dielectric thin film in which no dielectric breakdown of the self-healing type takes place even when the electrode of Au, Zn, Al or the like in thickness of several tens nm. This dielectric breakdown is ascribable to the inherent nature of the material. Although the reason can not be explained, it is seen that the aspect of the arc-discharge which is produced upon dielectric breakdown and effective to eliminate away the material of the upper electrode differs between the film in which dielectric breakdwon of the self-healing type will occur and the film whose dielectric breakdown is not of the self-healing nature.

In case the dielectric thin film whose dielectric breakdown is of the self-healing type is used as the dielectric thin film formed on the phosphor layer of the AC-driven thin film EL element, the dielectric breakdown occurring at the defective portion is of the first mentioned type. The material of the upper electrode is eliminated away over an area of several tens μm. Since an eliminated pinhole can not be visibly recognized, the dielectric breakdown of the self-healing type presents no practical problem. Since the dielectric thin film of the composition

expressed by the general formula of AB_2O_6 (where A represents a divalent metal element and B represents a pentavalent metal element) is susceptible to the dielectric breakdown of this type, it is preferred as the dielectric thin film for the AC-driven thin film EL element also in respect to the dielectric breakdown. On the other hand, when the dielectric film whose dielectric breakdown is not of the self-healing type is formed on the phosphor layer of the AC-driven thin film EL element, the dielectric breakdown occurring at the defective portion is of the second mentioned type. The dielectric breakdown is likely to spread over the whole pixels, producing a visible deficiency. In the case of an X-Y matrix array, a line defect will be resulted. Although the thin film of perovskite type titanate can be easily fabricated with a large value of ε_γ and exhibit E_b of a large value at the locations where no defects due to the pinholes and dusts are present, this film is insusceptible to the dielectric breakdown of the self-healing type. In particular, in the case of the thin film of strontium titanate or barium titanate having ε_γ of a great value, the dielectric breakdown of the self-healing type is difficult to occur, th se thin films w re not used for the AC-driven thin film EL element. However, when the dielectric thin film of the composition expressed by the general formula of AB_2O_6 mentioned before is formed on

the thin film of the above mentioned type, the dielectric breakdown occurring due to the pinholes and dusts is of the self-healing nature, to an advantage. In this way, by using a composite dielectric film formed by superposing a dielectric thin film having a larger value of $E_b \cdot \varepsilon_\gamma$ than the film expressed by the general formula of AB_2O_6 and insusceptible to the self-healing type dielectric breakdown and the aforementioned dielectric thin film expressed by the general formula of AB_2O_6 onto each other, the dielectric breakdown takes place in the form of the self-healing breakdown, while $E_b \cdot \varepsilon_\gamma$ of a larger value than that of the aforementioned dielectric thin film represented by the general formula of AB_2O_6 can be assured. It is desirable that $E_b \cdot \varepsilon_\gamma$ of the dielectric thin film insusceptible to the self-healing type dielectric breakdown is not smaller than 80.

Next, exemplary embodiments of the present invention will be described by referring to the drawings.

For facilitating the understanding, description will be made in conjunction with an example for comparison. Fig. 3 shows the example for comparison, and Fig. 4 shows an exemplary embodiment of the present invention. As is apparent from the drawings, Y_2O_3-films 33 and 43 each of 40 nm in thickness were formed by an electron beam evaporating method on glass substrates 31

and 41 deposited with transparent electrodes 32 and 42 of ITO (indium tin oxide), respectively. Subsequently, phosphor layers 34 and 44 of ZnS:Mn were formed through simultaneous evaporation of ZnS and Mn. Film thickness is 600 nm. Heat treatment was carried out at 580°C in vacuum for one hour. The elements was divided into five elements one 1 of which was used as a specimen for comparison and a Y_2O_3-film 35 of 400 nm thick was formed, as is shown in Fig. 3. ~~On the other hand, the element 2~~ was formed with a Ta_2O_5-film 45 of 30 nm in thickness for the protection of ZnS:Mn by an electron beam evaporating method, as is shown in Fig. 4, in accordance with an embodiment of the present invention. Subsequently, a film 46 of $PbNb_2O_6$ was formed through magnetron RF sputtering by using a ceramic of $PbNb_2O_6$ as a target. The atmosphere for the sputtering contains O_2 and Ar at the ratio of 1:4 at a pressure of 0.6Pa. ~~The temperature of the substrate is 420°C and the film~~ thickness is 700 nm. According to another embodiment of the present invention, the element 3 was formed with a film of $PbTa_2O_6$ in thickness of 700 nm on the same conditions as in the case of the element 2 except that a target of $PbTa_2O_6$ was employed in place of $PbNb_2O_6$.

In accordance with still another embodiment of the present invention, the element 4 was formed with a film of $BaTa_2O_6$ in thickness of 500 nm on the same conditions as in the case of the element 2 except that

$BaTa_2O_6$ was used in place of $PbNb_2O_6$ as the target.

According to a further embodiment of the present invention, the element 5 was formed with a film of $SrTa_2O_6$ in thickness of 450 nm on the same conditions as in the case of the element 2 except that $SrTa_2O_6$ was used in place of $PbNb_2O_6$ as the target.

The $PbNb_2O_6$-film, the $PbTa_2O_6$-film, the $BaTa_2O_6$-film and the $SrTa_2O_6$-film fabricated on the aforementioned conditions have characteristically E_b of 2.2×10^6 V/cm, 2.6×10^6 V/cm, 5.1×10^6 V/cm and 5.6×10^6 V/cm, respectively, and ε_γ of 70, 48, 27 and 25, respectively.

As is shown in Figs. 3 and 4, thin films of Al were deposited through vaporization to form light reflecting electrodes 36 and 47.

Each of the EL elements fabricated in the manner described above was driven by applying a sine wave voltage of a frequency of 5 KHz across the electrodes. The voltage at which brightness was substantially saturated in the stable state was 150 V in the case of the element 1, 100 V in the case of the element 2, 110 V in the case of the element 3, 125 V in the case of the element 4 and 125 V in the case of the element 5. The saturated brightness was about 3000 cd/m^2 in all of the five elements.

Next, an embodiment of this invention according to which an AC-driven thin film EL element

having a dielectric layer only on one surface of a phosphor layer and in which tungsten bronze type composite oxide film is employed will be described by referring to Fig. 5. A ZnO-film 53 having a thickness of 50 nm was formed by a sputtering method on a glass substrate 51 deposited with a transparent electrode 52 of ITO. The film 53 of ZnO has a resistivity of 8×10^{-3} Ω·cm and serves as a second electrode layer for preventing diffusion of In and Sn into ZnS from the transparent electrode 52 of ITO. Subsequently, ZnS and Mn were simultaneously evaporated to form a phosphor layer 54 of ZnS:Mn in thickness of 450 nm. Heat treatment was conducted at 580°C in vacuum for an hour. Further, a film 55 of Y_2O_3 having thickness of 20 nm was formed by an electron beam evaporating method for protecting the phosphor layer 54 of ZnS:Mn. Subsequently, a $PbNb_2O_6$-film 56 was formed by a magnetron RF sputtering method by using ceramic of $PbNb_2O_6$ as a target. Composition of the sputtering atmosphere is O_2:Ar = 1:1 (in volume ratio), and the pressure thereof is 1.3 Pa. The temperaure of the substrate is 320°C. film thickness is 500 nm. The film 56 of $PbNb_2O_6$ fabricated on the conditions mentioned above has characteristically E_b of 2.5×10^6 V/cm and ε_γ of 56. Finally, an Aℓ-thin film 57 was formed through evaporation as light reflecting electrode.

The EL element manufactured in the manner

described above was driven by applying a sine wave voltage of 5 KHz between the electrodes. Brightness was substantially saturated at about 70 V. In the stable state, brightness was 1900 cd/m^2.

A further embodiment of this invention will be described with the aid of Fig. 6.

As is shown in Fig. 6, a glass substrate 61 having a transparent electrode 62 of ITO was deposited with a Y_2O_3-film 63 in thickness of 40 nm through electron beam evaporation. Subsequently, a phosphor layer 64 of ZnS:Mn was formed in thickness of 1.0 μm by simultaneously evaporating ZnS and Mn through vacuum vapor deposition. Heat treatment was conducted at 580°C in vacuum for an hour. Thereafter, a Ta_2O_5-film 65 is deposited in thickness of 40 nm through electron beam evaporation for protecting the film of ZnS:Mn. The element is divided into two, one of which was deposited with a $SrTiO_3$-film in thickness of 1.4 μm while the other was deposited with a $BaTiO_3$-film in thickness of 1.6 μm by a magnetron RF sputtering method. A mixed gas of O_2 and Ar was used as the sputtering gas at pressure of 8×10^{-1} Pa. The temperature of the substate at that time is 420°C. Additonally, a $PbNb_2O_6$-film 67 was deposited in thickness of 0.4 μm by a magnetron RF sputtering method. A mixed gas containing O_2 and Ar at the ratio of 1 to 1 was used as the sputtering gas at a pressure of 0.6 Pa. A sintered body of $PbNb_2O_6$ was used

as the target. The temperature of the substate is 380°C. A film 68 of Al was deposited in thickness of 70 nm to form the upper electrode. A voltage was applied between the electrodes of the thin film EL element thus manufactured and the applied voltage was progressively increased. Before brightness was produced, dielectric breakdowns of small degree occurred at defective portions to form holes in diameter of about 30 μm in the Al-film 68 by elimination of the film material. The dielectric breakdowns were all of the self-healing type. The number of the breakdowns was 0.5/cm^2 in both elements. When the elements were driven by applying an AC pulse voltage of 5 KHz. Both elements were driven into the state in which brightness was substantially saturated when zero-to-peak voltage of about 230 V was applied. The brightness was about 7000 cd/m^2.

INDUSTRIAL APPLICABILITY

As will be appreciated from the foregoing, the thin film electroluminescent element according to the invention can be operated stably with a low driving voltage.

CLAIMS

1. A thin film electroluminescent element comprising a phosphor thin film, a dielectric thin film disposed on at least one surface of said phosphor thin film, and electrodes for applying a voltage across said films, characterized in that said dielectric thin film is constituted by a dielectric material having composition expressed by a general formula of AB_2O_6 where A represents a divalent metal element and B represents a pentavalent metal element.

2. A thin film electroluminescent element according to claim 1, characterized in that the divalent metal element A is at least one selected from a group consisting of Pb, Sn, Mg, Ca, Sr, Ba, Zn and Cd, and that the pentavalent metal element B is at least one of Ta and Nb.

3. A thin film electroluminescent element according to claim 1, characterized in that the divalent metal element A is at least one selected from a group consisting of Pb, Sr and Ba, and that the pentavalent metal element B is at least one of Ta and Nb.

4. A thin film electroluminescent element according to claim 1, characterized in that the divalent metal element A is Pb and that the pentavalent metal element B is at least one of Ta and Nb.

5. A thin film electroluminescent element according to claim 1, characterized in that the

dielectric thin film is constituted by a first dielectric thin film expressed by the general formula of AB_2O_6 (where A represents a divalent metal element and B represets a pentavalent metal element) and a second dielectric thin film which has a product $E_b \cdot \varepsilon_\gamma$ of dielectric breakdown electric field intensity E_b and dielectric constant ε_γ, said product being not-smaller than 80, and which is insusceptible to dielectric breakdown of self-healing type.

6. A thin film electroluminescent element according to claim 5, characterized in that the second dielectric thin film insusceptible to the dielectric breakdown of the self-healing type is formed of a dielectric material containing perovskite type titanate as a main component.

7. A thin film electroluminescent element according to claim 5 or 6, characterized in that the divalent metal element A is at least one selected from a group consisting of Pb, Sn, Mg, Ca, Sr, Ba, Zn and Cd, and that the pentavalent metal element B is at least one of Ta and Nb.

8. A thin film electroluminescent element according to claim 5 or 6, characterized in that the divalent metal element A is at least one selected from a group consisting of Pb, Sr and Ba, and that the pentavalent metal element B is at least one of Ta and Nb.

9. A thin film electroluminescent element

according to claim 5 or 6, characterized in that the divalent metal element is Pb, and that the pentavalent metal element is at least one of Ta and Nb.

FIG. 1

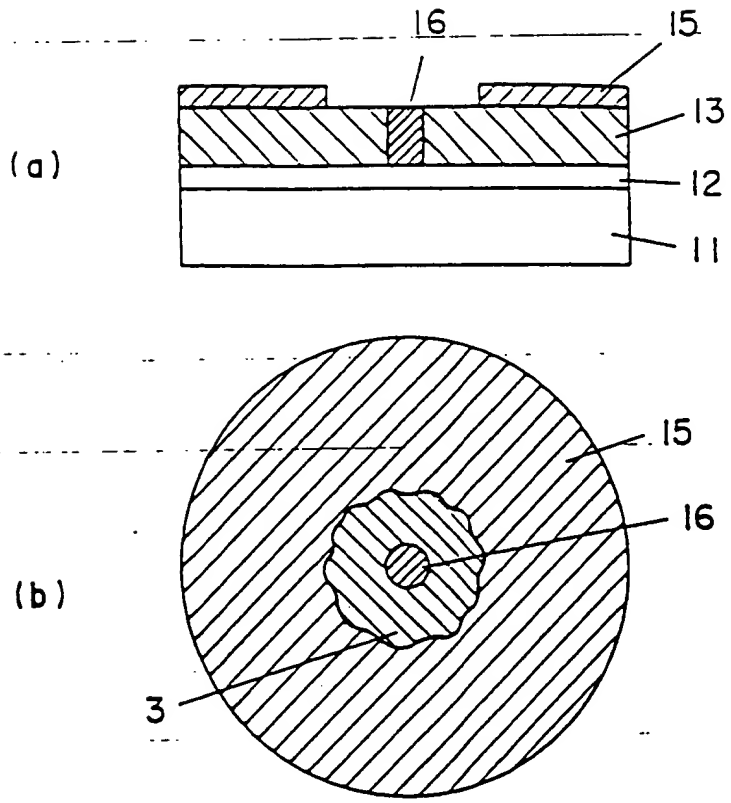


FIG. 2

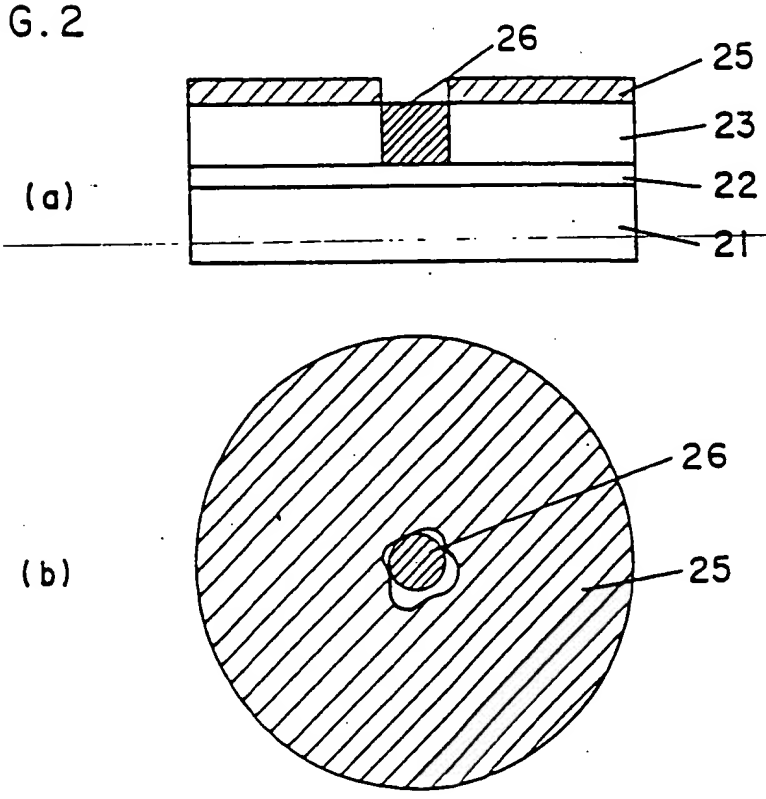


FIG. 3

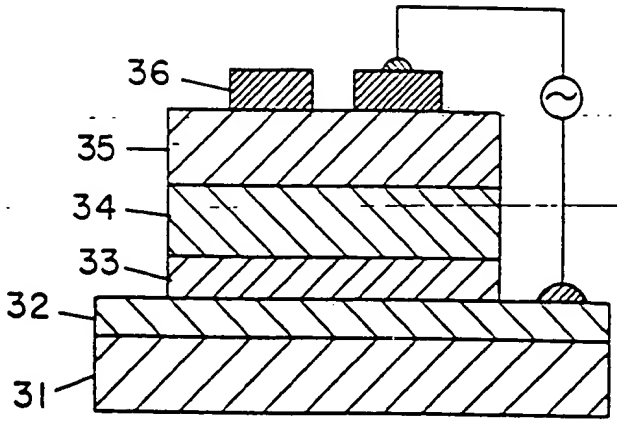


FIG. 4

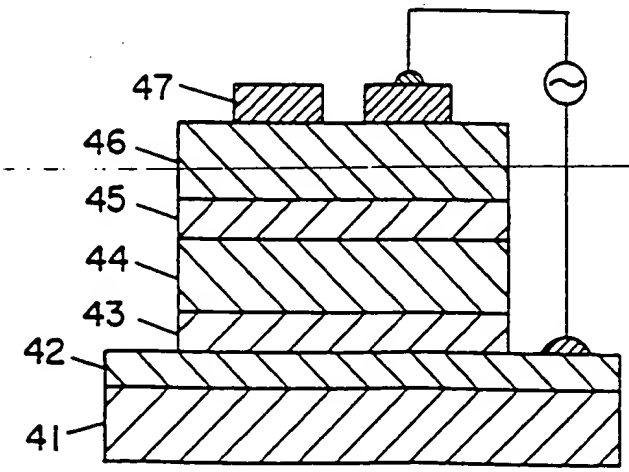


FIG.5

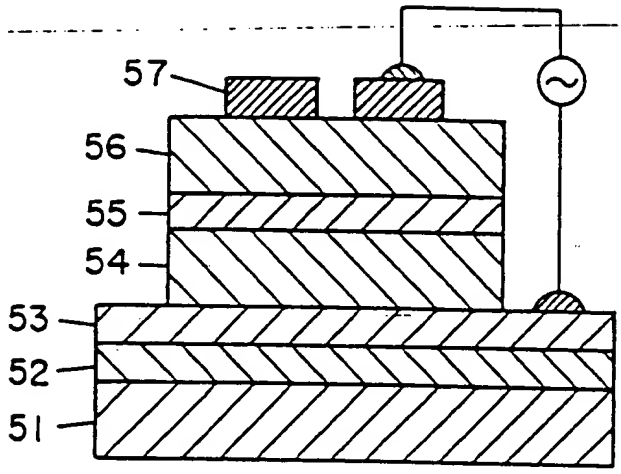
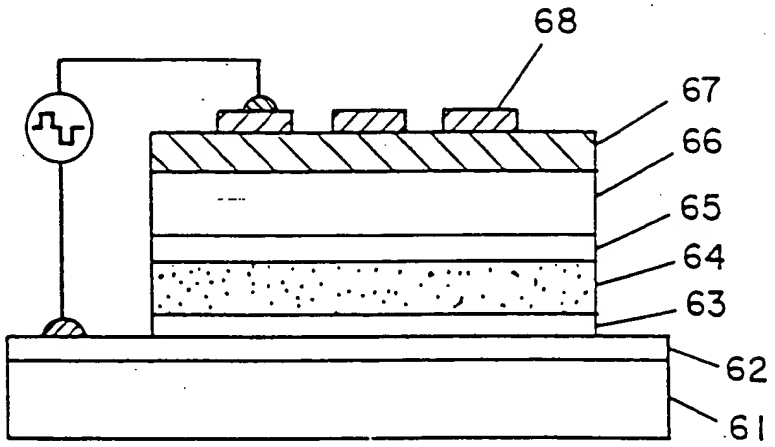


FIG. 6



LIST OF REFERENCE SYMBOLS IN DRAWINGS

11 ..... substrate

12 ..... lower electrode

13 ..... dielectric thin film susceptible to dielectric breakdown of self-healing type

15 ..... upper electrode

16 ..... location where dielectric breakdown occurred

21 ..... subsstrate

22 ..... lower electrode

23 ..... dielectric thin film susceptible to dielectric breakdown of self-healing type

25 ..... upper electrode

26 ..... hole formed by dielectric breakdown

31 ..... glass substrate

32 ..... transparent electrode

33 ..... Y_2O_3-film

34 ..... phosphor layer of ZnS:Mn

35 ..... Y_2O_3-film

36 ..... light reflecting electrode

41 ..... glass substrate

42 ..... transparent electrode

43 ..... Y_2O_3-film

44 ..... phosphor layer of ZnS:Mn

45 ..... Ta_2O_3-film

46 ..... $PbNb_2O_6$-film

47 ..... light reflecting electrode

51 ..... glass substrate

INTERNATIONAL SEARCH REPORT

0111568

International Application No PCT/JP83/00164

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] H01B 3/12, H01G 4/08, H05B 3/22

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
I P C	H01B 3/12, H01G 4/08, H05B 3/22

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho	1926 - 1983
Jitsuyo Shinan Kokai Koho	1971 - 1983

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category [15]	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	GB,A, 798,503 (Thorn Electrical Industries Ltd.) 23. July. 1958 (23. 7. 58) Page 2, lines 14 to 19	1 - 4
Y	JP,B1, 32-1886 (General Electric Co.) 22. March. 1957 (22. 3. 57)	1 - 4
Y	JP,A, 55-10447 (Nippon Electric Co., Ltd.) 24. January. 1980 (24. 1. 80)	1 - 4
Y	JP,A, 57-35891 (Fujitsu Ltd.) 3. March. 1982 (3. 3. 82)	5 - 9
Y	JP,A, 56-45595 (Fujitsu Ltd.) 25. April. 1981 (25. 4. 81) Column 7, lines 1 to 4	6

* Special categories of cited documents: [19]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [1]	Date of Mailing of this International Search Report [2]
August 11, 1983 (11.08.83)	August 29, 1983 (29.08.83)

International Searching Authority [3]	Signature of Authorized Officer [20]
Japanese Patent Office	